**Sustainable Agriculture Research and Education Program**
**and Agriculture in Concert with the Environment**

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4. **Project status:** Not applicable

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7. **Cooperators:** Mr. P. Wafler, (grower); Mr. L. Wells, (grower); Mr. C. Yunker (grower); Ms. L. Pedersen, (county agent); Dr. C. Petzoldt, (IPM); Mr. A.S. Connell, (U.S.D.A. Soil Cons. Ser.); and Mr. G. Ivison (Comstock Foods).

8. **Grant number:** OSP #19284

9. **Funding period:** June 1, 1990 through May 31, 1991.

10. **Funding to date:** $68,500

**11. Abstract**

The results of a single year's experimentation on the potential ability of different mulches (living and dead) to suppress weeds and allow herbicide rates to be reduced in vegetable production are reported. In general, fall-planted mulches suppressed weeds for two to six weeks after seeding or transplanting various crops (snap beans, sweet corn, cabbage, tomatoes, potatoes). Grain rye regulated with glyphosate, followed by winter-killed oats and hairy vetch, provided the greatest early season weed suppression. Weeds tended to proliferate in hairy vetch later in the season. Later season weed control was less a function of the mulches but more a function of the efficacy of the herbicides used in the various crops. Those used in beans and sweet corn, potatoes and tomatoes in New York, were largely effective at reduced rates, and weed control throughout the season was good. In cabbage, the postemergence herbicides were less effective than

those used in the other crops and the herbicide rate reduction was only successful in a year (1990) when weed populations were low. Fall-planted white clover in the living mulch studies (Connecticut), successfully suppressed weeds in both snap beans and sweet corn but made seeding difficult, particularly in beans. Spring planted living mulches (red clover, red fescue) provided less weed suppression and were potentially too competitive.

All systems evaluated require additional study to correct or finetune methodology. It is accepted that these systems are more difficult to manage than conventional systems and may prove to be more appropriate for use by smaller producers.

**12. Objectives:**

1. To evaluate potential cover crop/mulch species for their ability to suppress weeds, conserve moisture and reduce erosion.
2. To determine the yield potential of numerous vegetable crops grown throughout the Northeast when produced in strip or reduced tillage systems.
3. To utilize the weed suppressing potential of a mulch to reduce rates of applied herbicides.
4. To determine the comparative costs involved with each mulch/tillage/herbicide system.

**13. Project findings.**

This was intended to be a multi-year project. Using the first year's planning funds ($10,000), the various mulch systems were established in the 1989 season. The following year, 1990, was the first year of data collection and was the only year that additional funding was received. Consequently, the results presented as the annual report are identical with the final report and are repeated here in an abreviated form. Subsquently, a graduate student project with cabbage was completed on other funds. Those results are also included.

**Experiment Location: Cornell University, Ithaca, NY**

During 1990, five studies were conducted at the Vegetable Crops Research Farm in Freeville, NY to evaluate the production of vegetables when managed under several mulch/cover crop systems. The vegetables evaluated were: reduced-tillage potatoes grown in chemically-regulated red clover; no-till snap beans and strip-till sweet corn in killed rye; strip-till cabbage in winter-killed mulches; and strip-till tomatoes grown in mulches regulated by winter-killing, mowing, or chemicals. Reduced herbicide rates and total post-emergence herbicide programs were evaluated against traditional full rates and preemergence programs in all studies.

**Results: Snap Beans.** Excellent control of the two major weeds, redroot pigweed and common lambsquarters was achieved with all programs except the conventional tillage control through July 7th. By August 14, two weeks before harvest, all herbicide programs continued to give greater than 90% control of both weeds. Where cultivation alone was used, control was inadequate. When comparing weedy checks, the rye residues continued to give greater than 50% weed suppression. With the exception of the weedy checks, snap bean yields did not differ with herbicide or tillage programs. The results suggest that yields did not suffer with the reduction in herbicide rates or with the use of a total postemergence program. Additionaly, yields were not lower in the cultivation alone treatment despite the poor weed control. All plots, however, were hand-harvested and the weeds present in these plots may have caused lower yields if the plots had been machine-harvested.

**Results: Sweet Corn.** Similar to the case of the snap beans, control of redroot pigweed and common lambsquarters was excellent with all herbicide programs, both the reduced and full rates, until harvest in mid-August. Weed suppression with the rye mulch alone was less, there being little effect on pigweed by harvest. Yields did not differ with either herbicide program or tillage system and was largely due to the excellent season-long weed control. A comparison of yields in the weedy checks, however, indicated that the strip-till rye residue system outperformed the conventional system by 34%. Additionally, when comparing yield reduction in the individual control plots to the average of the corresponding herbicide-treated tillage systems, yields of weedy plots in conventional tillage were reduced by 55%, while a 38% reduction occurred in the strip till system. This indicated that the early suppression of weeds in the strip-till system helped decrease yield losses.

**Results: Potatoes.** Prior to hilling, there was an average of 43% mulch cover within reduced tillage plots, while in the conventional system, 5% or less of the mulch remained. Although glyphosate, 2,4-D, and paraquat were applied to control the clover before planting, it was not completely killed until metribuzin and metolachlor were applied. This indicates that clover may prove to be a difficult mulch to regulate. In contrast to other mulch studies where residues have suppressed weed populations, the reduced tillage weedy check plots had significantly higher weed populations than did the conventional tillage weedy plots. Yields in these plots were 14% lower than in conventional tillage. When herbicides were used, no significant yield differences between tillage systems, or herbicide programs were observed.

**Results: Tomatoes.** Mulches used in this study were: grain rye, hairy vetch, red fescue, red clover, winter-killed spring oats, annual ryegrass, and conventional tillage. At the time of transplanting, mulch control was complete in rye, oats, and annual ryegrass. Red fescue, red clover and hairy vetch continued to grow despite regulation attempts. Approximately three weeks after transplanting, percent mulch cover averaged across herbicide treatments were highest in rye (dead) and red fescue (living) at 80%. Oats and annual ryegrass were lowest, with less than 2% cover. Initial herbicide treatments were applied 10 days after transplanting (DAT) in oats, 20 DAT in annual ryegrass, hairy vetch, and red clover, and 34 DAT in rye and red fescue. Mulches requiring two applications of herbicides were annual ryegrass, and red clover. Within the individual mulches there were no significant differences in percent weed cover regardless of herbicide rate. In comparing mulch systems across herbicide treatments, two levels of weed control were observed: greater than 95% in bareground, rye and red fescue, and 65-85% in red clover, hariy vetch, annual ryegrass, and oats. Weed spectra varied due to differences in mulch establishment and regulation. When comparing untreated mulches, yields were decreased in red clover, oats, annual ryegrass and bareground plots when compared with rye. When averaged across herbicides, yields were lowest in red clover and red fescue and highest in rye.

**Results: Cabbage.** This study evaluated the weed suppressive effects of grain rye, winter-killed spring oats, winter-killed lana vetch, hairy vetch, Austrian winter peas, crimson clover, and mixtures of oats with each of the legumes. Additionally, reduced and full rates of post-emergence herbicide programs were evaluated. Pretransplanting weed cover in 1990 was 30% in the bareground control and an average of 3% in mulch plots; and 86 and 27%, respectively, in 1991. By midseason, 1990 weed cover was3% in conventional tillage and 5% in reduced tillage plots; in 1991, these numbers were 22 and 33%, respectively. Weed populations in conventional tillage were generally greater and cabbage yields less, than in reduced tillage. Effective weed suppression, particularly early in the season, was strongly correlated with high mulch biomass and cover.

In general, winter-killed and spring-killed mulches performed similarly. Rye, however, suppressed weeds better than oats; and hairy vetch was somewhat superior to lana vetch. Grass mulches, particularly rye, were superior to legumes. Among the legumes, Austrian winter peas provided least weed suppression. Polycultures tended to provide greater weed suppression than did the legumes alone. Significant early season weed suppression resulted from the use of mulches, but midseason weed pressure made clear the need for postemergence weed control alternatives.

Full- and half-rate applications of herbicides were not different with respect to weed suppression or cabbage yield in 1990. However, in 1991, owing to significantly greater weed pressure and dry weather conditions, the higher rate suppressed weeds better than the lower rate in all mulches. All weed control treatments produced yields inferior to those of the handweeded control, suggesting that the mulches and herbicides evaluated will require additional study and refinement in application timings and methodology.

**Experiment Location: University of Connecticut, Storrs, CT.**

**Results: Living Mulches.** Living mulches showed considerable promise for their weed suppressing potential in snap bean and sweet corn production. White clover, red clover and red fescue mulches reduced total weed biomass on a dry matter basis by 99, 41, and 27% respectively compared to conventionally-seeded plots for snap beans, and by 63, 9, and 7%, respectively for sweet corn. White clover may have been more effective for weed control than the others because it was established in the fall before the growing season.

**Results: Herbicide Program Evaluation.** The narrow window of application times for some standard herbicide treatments in snap beans and corn produced negative results because of the particular growing conditions in 1990. Broadleaf weeds were too large when the bentazon treatments were applied to the beans. Similarly, metolachlor was not applied in corn postemergence because the corn had already exceeded the appropriate growth stage for herbicide application by the time postemergence control was necessary. Addtionally, lack of precipitation following herbicide application reduced herbicide efficacy. Herbicide programs that allowed greater flexibility would improve the potential to reduce overall reduction in herbicide use.

**Results: Crop Response.** Beans grown in the spring-planted red fescue and red clover mulches produced yields similar to conventionally grown beans. Those grown in white clover were reduced. This difference was attributable to seeding differences. The fall-planted white clover proved to be difficult to plant into and plant stands were lower in these plots. Improvements in planting techniques will be required if this system is to be successful. Sweet corn yields were highest in white clover, moderately reduced in red clover, and drastically reduced in red fescue. The yield reductions were a function of weed and mulch competition. Fall establishment or increased seeding rates for spring mulch establishment would increase the weed suppression potential of the mulches, however, mulch regulation to reduce mulch competition will be necessary.

# New Cultivation Tools for Mechanical Weed Control in Vegetables

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The recent trend toward restricting herbicide use has produced interest in alternative and integrated weed control strategies that include cultivation. As a result, newly developed implements are now available to vegetable growers, but the potential uses of these tools for numerous vegetable crops can be confusing. This publication describes some of these tools and their advantages and disadvantages, based on four years of research at Cornell University. It should be noted, however, that this is not a complete list; several other designs are available that were not tested in these trials.

## Flex-tine harrows

Flex-tine harrows are used broadcast, both over and between the crop rows. They are most efficient when weeds are in the white-thread or cotyledon development stage. In direct-seeded crops, such as snap beans or sweet corn, flex-tine implements are used preemergence. Tines pass above the planted seed. Harrowing can be repeated postemergence for control of newly germinated weeds, but only when the crop is well-rooted. Cultivation intensity can be modified to minimize crop damage. Guide wheels and tine intensity regulate harrowing depth.

### Advantages

- Tools are available in large widths (up to 40') and are operated at high speeds when used preemergence.
- Flex-tine implements are useful for a number of crops and row spacings with little or no equipment modifications.
- Tines that pass over the crop row can be lifted, allowing for aggressive between-row harrowing when the crop is sensitive to cultivation damage.
- Preemergence harrowing breaks crusted soils and may increase crop emergence rates.

### Disadvantages

- Cultivation timing is critical; weeds with four or more leaves and emerged grasses at any stage are rarely controlled. Therefore, early-season flex-tine harrowing should be integrated with a more aggressive cultivator or with postemergence herbicides for control of escaped or newly germinated weeds.
- Research in transplanted broccoli, snap beans, and sweet corn has shown that flex-tine harrows can reduce crop stand and yield when used before the crop is well-rooted.

## Implement Descriptions

### Einbock flex-tine harrow

The Einbock harrow (Fig. 1) has floating beds of tines mounted on a tool bar. Cultivation on uneven ground or hillsides is possible with the floating bed system. Tines can be lifted above the crop row; however, tine intensity is modified on a bed-by-bed basis with a single adjustment.

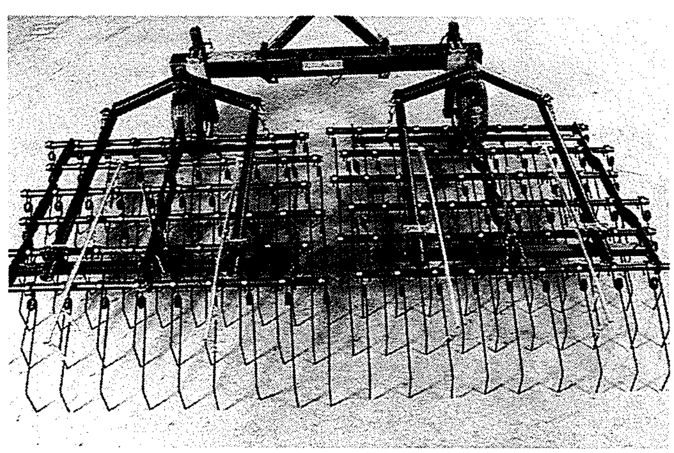


Fig.1

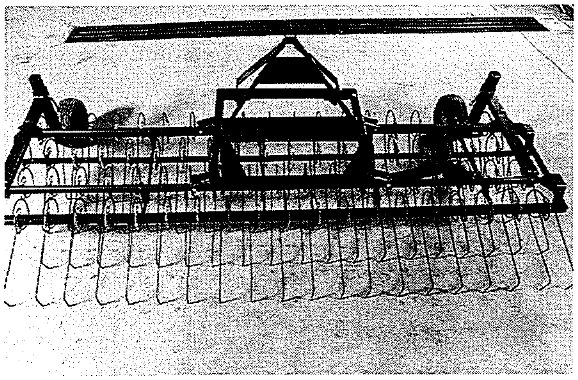


Fig.2

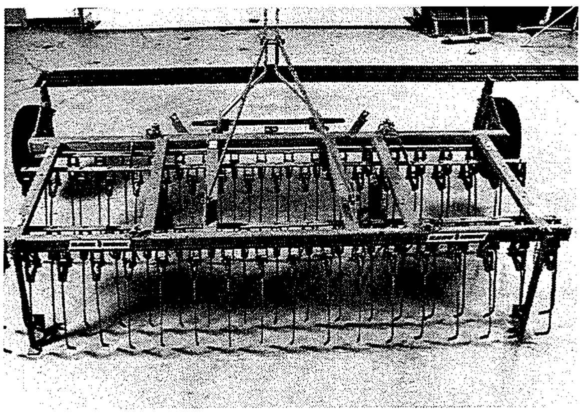
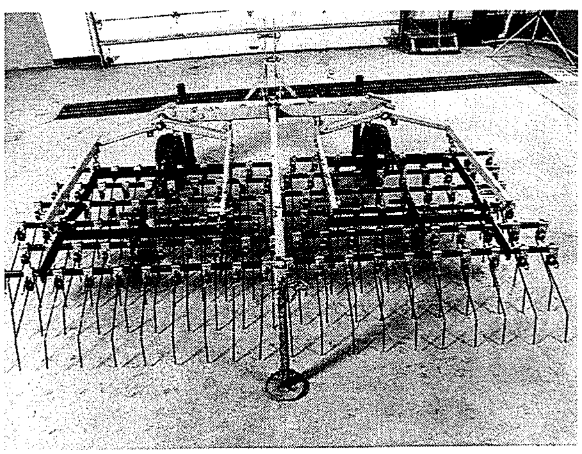


Fig.3



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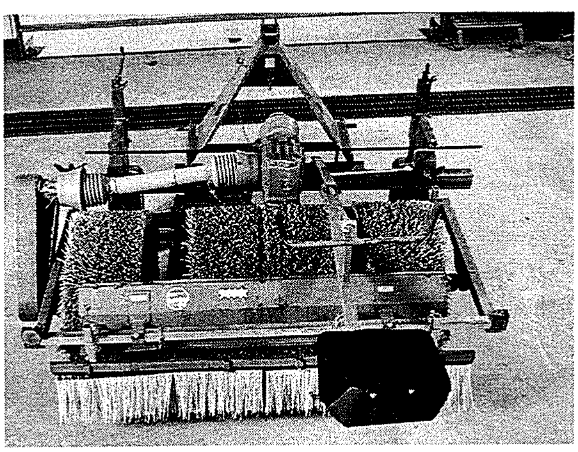

Fig.5

**Lely flex-tine harrow**

The Lely harrow (Fig. 2) is a lightweight tool with very flexible tines that vibrate to rip weeds from the soil. The implement's light weight can be a "cure or curse"—the harrow is easily maneuvered with a low-horsepower tractor, but its cultivation efficiency is reduced on hard-packed or crusted soils. Tine intensity is modified on a tine-by-tine basis.

**Rabe Werk flex-tine harrows**

Rabe Werk manufactures two harrows: one having flat tines (Fig. 3) and one with round tines (Fig. 4). The flat-tined harrow is very aggressive and effectively breaks crusted soils. Tines are modified individually in three intensities: high, low, and tines lifted above the crop rows. The round-tined implement is similar to the Einbock harrow and has floating beds of tines.

## The Baertschi brush hoe

The brush hoe has PTO-driven plastic bristles that rotate on a horizontal plane, aggressively ripping weeds from the soil (Fig. 5). Shields, hung above the soil surface, protect the crop from the rotating brushes but allow soil to move into the crop row. Because the tool is very aggressive and precise, an additional operator (on the rear seat) is required to steer the shields over the crop row. Cultivation depth is modified with guide wheels and the three-point hitch attachment. Several row spacings and brush configurations are available.

### Advantages

• The aggressive nature of the brush hoe increases the length of time available for effective cultivation; weeds up to ten inches tall can be controlled.

• The implement is effective on slightly moist soils.

• Soil passing under the shields smothers weeds in the crop row.

• The dust layer that results from brushing delays new weed germinations. For example, in transplanted broccoli, a single pass of the brush hoe provided season-long weed control comparable to standard herbicides without reducing yields.

### Disadvantages

• The brush hoe requires two operators.

• Wind erosion is possible with aggressive brushing on dry soils.

• Row spacing modifications are expensive and time consuming; therefore, all cultivated crops must have the same spacing.

• The initial implement purchase is costly.

## The Buddingh finger weeder

The finger weeder is designed specifically for in-row weed control (Fig. 6). The tool has three pairs of ground-driven rotating fingers: two pairs in the front push soil and uprooted weeds away from the crop row; while the third pair pushes soil back into the row, covering weeds that were missed by the other fingers. The weeder is most effective when fingers pass very close to the crop row; therefore, precise cultivation and slow driving speeds are important. The finger weeder is most effective on small-acreage, high-value crops.

### Advantages

- The weeder offers excellent in-row weed control.
- The finger weeder is a lightweight tool and can be mid-mounted on a small tractor.

### Disadvantages

- The weeder must be used when weeds are small; therefore, timing is critical.
- Between-row control is poor. Finger weeders should be used in combination with an inter-row cultivator.
- Slow, precise cultivation is necessary to minimize crop damage.

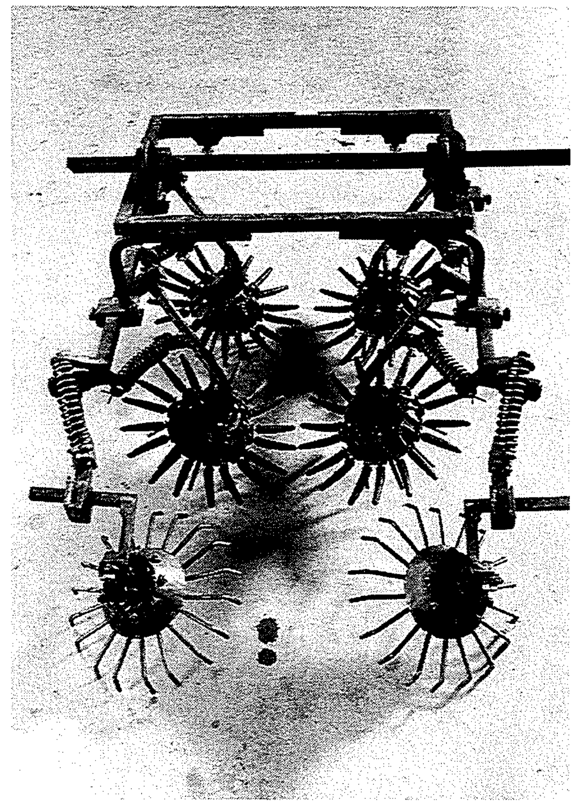

Fig.6

## Bezzerides torsion weeder

The torsion weeder is mounted on an existing inter-row cultivator for improved in-row weed control (Fig. 7). This simple tool has spring-loaded steel rods on each side of the crop row that undercut small weeds. The width of the uncultivated strip is easily adjusted for each crop and development stage.

### Advantages

- The torsion weeder offers excellent in-row weed control.
- The simple design minimizes potential cultivator repairs.
- The torsion weeder is an economical addition to an existing cultivator.

### Disadvantages

- Careful, accurate cultivation is important.

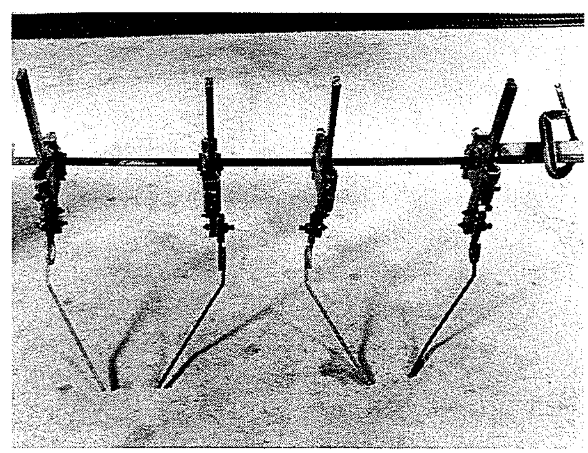

Fig.7

## Integrated Management Strategies

The best weed control strategy often integrates several management strategies, which may include mechanical control. Two ways to reduce herbicide use while minimizing the risk of poor weed control and reduced yields are to combine cultivation with banded herbicides or with some of the new postemergence herbicides (e.g., Reflex and Basagran for snap beans), used on an as-needed basis. Research in sweet corn, for example, has shown that yields were equivalent when a single cultivation was combined with Dual and Atrazine banded over the crop row and when the same herbicides were applied broadcast without cultivation, even in wet years. Results were similar in potato studies, where the combination of banded herbicides and a single hilling six weeks after planting produced yields equivalent to broadcast herbicides plus hilling.

# Manufacturers

## Brush hoe

Baertschi FOBRO
1715 Airpark
Grand Haven, MI 49417
Phone: 616-847-0300
Fax: 616-842-1768

## Finger weeder

Buddingh Weeder Co.
7015 Hammond Ave.
Dutton, MI 49316
Phone: 616-698-8613

## Torsion weeder

Bezzerides Brothers, Inc.
P.O. Box 211
Orosi, CA 93647
Phone: 209-528-3011

## Flex-tine harrows

**Einbock:**

Landaschinenbau GES. m.b.h. & Co. KG
A-4751 Dorf an der Pram
Austria
Phone: 43-7764-6466
Fax: 43-7764-65-3585

**Canadian Distributor:**

HWE-Agricultural Tech. Ltd.
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**Rabe Werk:**

Machinerie Agricole St. Cesaire Inc.
C.P. 399, 650 Route 112
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Phone: 514-469-4081
Fax: 514-469-3659

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